

DR1

DIGITAL REVERBERATION SYSTEM

Owner's Manual

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INTRODUCTION

The ART DR1 Digital Reverberation System is a high definition digital signal processing device providing realistic natural reverberation as well as creative new reverb and delay based effects.

In designing the DR1, ART incorporated the latest findings in digital reverberation research and gave careful consideration to user feedback on desirable features. Microcomputer control of a high speed digital signal processor allows quick and easy adjustment of relevant reverb parameters such as room size, "liveness", color and depth. Microcomputer control also permits us to redefine the front panel controls when creating special effects and allows for future growth. ART technology makes it affordable.

User oriented front panel controls, or the full function REMOTE; allow you to access and modify all relevant reverb parameters.

Once you achieve a desired sound, you can store the settings for later recall in one of a hundred user presets. Or you may choose the preprogrammed factory presets. The presets are nonvolatile, meaning they'll still be there when you power up again.

The DR1 not only replaces spring and plate reverbs, it can simulate both natural and larger than life environments in demanding stage and studio applications. The DR1 is quiet and clean, and may be switched to accommodate high or low signal levels. The two inputs are balanced and the output jacks provide stereo or mixed mono signals capable of driving line levels into 600 ohms.

Special consideration was given to features that make the DR1 more convenient to use in line with consoles or musical instruments. Left and right reverb level controls, in conjunction with the stereo/mono inputs and outputs are useful when no other mixing or level adjustment facilities are readily available. A rear panel dry kill switch removes the dry signal from both outputs when external mixing is desired.

We recommend that you first read these instructions to learn more about the DR1 Digital Reverberation System and its operation. Keep in mind that the settings described here are only a starting point. There is no substitute for hands on experience. Experiment for yourself.

INSTALLATION

In this section we'll discuss some general considerations for setting up and installing the DR1 Digital Reverberation System and cover what connections go where. We'll also discuss the setting of rear panel and internal switches which, normally, are set once and are thus not part of the day-to-day operation of the unit. Note that, throughout the rest of this manual, whenever we refer to actual labels, we'll indicate them by using all upper case letters (e.g. the ROOM control).

OPERATING ENVIRONMENT

The DR1 is an outboard device which may be used in a variety of setups including:

- * mixing consoles having reverb send and return facilities
- * directly in line between a musical instrument and an amplifier
- * in the effects loop of an amplifier

Your intended application will dictate the mounting requirements and which of the switch settings and connections discussed below are most appropriate.

The DR1 is designed for convenient mounting in a standard EIA nineteen inch rack and occupies one vertical rack position (1.75 inches high). As with any rack mount equipment, especially single high units, care should be taken to support the rear of the unit if the rack might be subjected to mechanical shock (in a touring case for example).

The mounting location is not critical, but for greater reliability we recommend that you not place the unit too near to power amps, power supplies, tube equipment, or other sources of heat. The DR1 itself runs warm to the touch normally, so if possible allow at least an inch above and below the rear of the unit for convection cooling.

INSTALLATION

LEVEL SETTINGS

The rear panel IN/OUT LEVEL switch selects between two operating ranges for optimum signal level matching:

1) The HIGH position (pushbutton out) selects nominal input/output operating levels of 0 dB (+12 dBV max. input). Use this position with line level console or amplifier loops.

2) The LOW position (pushbutton in) selects nominal input/output operating levels of -12 dB (0 dBV max. input). Choose this position for in line use with amplified musical instruments and lower level recording equipment.

Refer to the discussion of the level display in the Controls and Operation section for more information on setting the IN/OUT LEVEL switch.

BASS ROLLOFF SWITCH

The BASS ROLLOFF switch allows you to tailor the low end response of the DR1 to suit your requirements. Low frequency filtering is applied to the incoming signal before it is sent to the digital processing circuitry. The switch selects between two rolloff frequencies, 50 and 150 Hz. Units are shipped from the factory with the switch set in the 50 Hz position. We feel this setting is optimum for most applications as it approximates the spectral balance of natural reverberation. However, if it's not optimum for your application, you can change it.

The switch is located inside the DR1 and requires the removal of the top panel for access. You'll find the switch, labeled S2 on the printed circuit board, near the rear panel DRY KILL switch. Position the slider toward the rear panel to select the 50 Hz rolloff frequency. Position the slider away from the rear panel for 150 Hz. (Both positions are labeled).

CONNECTIONS

All connections to the DR1 are made at the rear of the unit via three types of jacks. Audio connections are made to jacks which accept standard 1/4-inch phone plugs. The REMOTE interface connector is a standard six position four pin modular telephone jack. MIDI connections are accomplished via standard five pin "DIN" jacks.

INSTALLATION

Inputs

The input impedance of each input is 47k ohms, balanced using active circuitry. Configured for a wide variety of inputs, the DR1 will accept true stereo or mono signal information. True stereo processing is accomplished by using both inputs in a left/right application. When connecting to consoles (or any stereo source) with stereo sends, connect the two independent sends to the corresponding input jacks. If only one input is used, the signal is automatically routed to both channels.

Outputs

All outputs are single ended and mate with two conductor phone plugs. Each output has a source impedance of 1k ohm and can drive full output levels into 600 ohm line impedances.

The LEFT and RIGHT stereo outputs provide true stereo, stereo image, or mono output. When a true stereo signal is applied to the inputs, the resulting output is true stereo. If both outputs are used with a mono input signal, a stereo image is produced simulating two microphones in a reverberant space. Using one output with a mono or stereo source provides a mono signal combining the reverberant information from both stereo outputs.

The outputs provide a mixed signal containing both reverberant and dry (unprocessed) information. The front panel REVERB LEVEL controls vary the relative amount of reverb in the mixed output signal. This mixing capability is especially useful for in line use with musical instruments where external mixing facilities are neither available nor otherwise needed. Pushing the rear panel DRY KILL pushbutton in removes the dry signal from the mixed outputs to allow external mixing of the reverb signal.

External KILL/INF

The rear panel also includes a 1/4-inch phone jack labeled KILL/INF which provides an optional means of activating the selected K/I mode. This is designed to be used with a momentary, normally open switch connected between a two conductor phone plug's tip and sleeve terminals. The operation of this control is discussed later in the section on Controls and Operation.

INSTALLATION

REMOTE

The REMOTE jack on the rear panel is a standard female six position four pin modular telephone jack. This jack provides for the DR1's REMOTE CONTROL module functions. Operation of the REMOTE CONTROL is discussed later in the Controls and Operation section. A standard modular telephone extension cable may be used to extend the distance from the REMOTE CONTROL to the main unit.

MIDI Connections

These jacks are standard five pin DIN connectors that provide connection and interfacing to other MIDI related devices. A more detailed description and operation is discussed later in the MIDI section.

AC Mains

The DR1 Digital Reverberation System operates from a power source of 105 to 125 volts AC (50-60 Hz). Models manufactured for use outside the United States are modified to comply with the electrical standards for the country of destination. The mains transformer is fuse protected against overload.

CONTROLS AND OPERATION

The main controls of the DR1 are divided into two primary sections, PRESET and VALUE on the front panel. Each section consists of pushbuttons and a universal display which select, modify, and indicate the parameters, respectively. Selection of parameters via the REMOTE or MIDI is handled differently and is covered later in this section.

When the DR1 is running, it requires a set of values to know what to do. These values (sometimes referred to as parameters) are held in the front panel and are always accessible. The set of values held in the front panel are always active and determine what the unit is doing. When a STORE takes place, the values that are displayed in the front panel are saved in the preset shown in the PRESET display. When a RECALL takes place, values are brought into the front panel for use. The VALUES in the front panel may be modified without affecting the preset indicated by the number displayed in the PRESET display.

PRESET OPERATION

The DR1 has one hundred user programmable presets (00-99) which can be stored, recalled, and locked from the front panel. In addition to these, there are thirty Factory Presets (F0-H9), permanently stored, that can cover a wide range of applications and provide a convenient starting point for generating your own presets. The preset memory is nonvolatile, a long life battery preserves the contents whether or not AC power is applied.

MIDI parameters (PGM, CHAN) are handled differently by the DR1 than other VALUE section parameters and are therefore not affected by the PRESET sections controls.

The up/down pushbuttons change the indicated PRESET in the display. Their operation is covered in the next section.

The RECALL pushbutton, when pressed, recalls the displayed preset and lights the CURRENT light.

When the CURRENT light is on, it indicates that all the parameters in the VALUE section match the preset chosen. If you change a VALUE parameter the light will go out. If you return the VALUE parameter to match the presets value the light will go back on. You can also use the CURRENT light to find other presets that have the same VALUE parameters.

CONTROLS AND OPERATION

The STORE pushbutton, when pressed, stores all the parameters in the VALUE section into the chosen preset, if the LOCKED light is off.

When the LOCKED light is on, it indicates that the chosen preset cannot have its values modified and then stored without unlocking it first. The indicated preset can still be recalled and have its VALUE parameters temporarily modified. The LOCK pushbutton is used only if you want to lock a PRESET's parameters so that they cannot be accidentally modified by the STORE pushbutton. The pushbutton is purposely located behind the front panel to prevent someone from inadvertently locking or unlocking your presets. Using a pencil, pen, or pointed object, lightly press the pushbutton. If the preset was unlocked it will become locked as indicated by the LOCKED light, pressing again will unlock the preset.

Presets F0 through H9 are factory presets that are permanently stored in R.O.M. (Read Only Memory) along with the rest of the DR1's instructions and therefore cannot be modified by the user. The LOCKED light is on when one of these presets is chosen. The LOCK pushbutton has no effect on them. A description of each factory preset and its parameters is at the end of this section for reference.

PRESETS 00 through 99 are user presets and may be modified, stored, recalled, locked, and unlocked. From the factory, they are all unlocked, and have factory presets loaded into them as a starting point.

Presets may be transferred by recalling a preset with the RECALL pushbutton then moving to another preset with the up/down pushbuttons, and then pushing the STORE pushbutton, as long as you are not trying to store into a factory preset or a locked preset.

You can use this feature to recall a Factory Preset, move up to a user preset and store it there. You can then modify any of the VALUE parameters of that preset and store them in the same or a different user PRESET.

As you run through the presets, you will find one with "-.-". This is the "Kill" preset. It is primarily used with MIDI. Calling this preset has the effect of killing the reverberant signal. The "Kill" preset is covered in more detail in the MIDI section.

CONTROLS AND OPERATION

VALUE OPERATION

In the VALUE section two color LEDs (green/red) indicate which reverb parameter is currently being displayed in the three digit VALUE display.

Selected values are changed by pressing the up/down buttons (indicated by arrows next to them). Momentarily pressing a button will step the display value up or down as indicated by the arrow. Holding a button down will increment or decrement the value automatically. A FAST mode to incrementing or decrementing quickly is provided. This is accomplished by pressing and holding first one button then pressing and holding the opposite button (e.g. to increment up quickly press and hold the arrow up button, then press and hold the arrow down button simultaneously). This FAST mode feature also applies to the up/down pushbuttons in the PRESET section.

To select a reverb VALUE parameter from the front panel, simply depress the pushbutton under the desired value. Pushing the button once will provide you with the parameter labeled in green, and the LED indicator will light green. Depressing the same button again will select the parameter labeled in red, and the LED indicator will light red. Example: To select PRE DELAY first, DIFFUSION second; depress once the pushbutton directly below the labeled parameter, the LED will be green and the PRE DELAY value will be displayed in the VALUE window. Push the same button again and the LED will be red, the DIFFUSION value will now be displayed in the VALUE window. To return to PRE DELAY, push the button again, or select another VALUE parameter.

The following description of VALUE parameters applies to all normal room types (P1-5, R1-5, H1-5, EF1). Special effects ROOMS (EF2, ERO, EGO,DDL) have different parameters and will be discussed separately.

ROOM

When the green light under ROOM is on, the VALUE display will indicate which ROOM type is active. The DR1 implements a different algorithm for each of its room types. Each room has its own unique image, early reflection characteristics, decay characteristics, and equalization properties. A description of each room is at the end of this section for reference.

CONTROLS AND OPERATION

PRE DELAY

In conventional recording practice, a delay is often inserted between the console and the reverb chamber. This "pre delay" serves two functions:

- 1) to add an apparent depth to the reverb sound, and
- 2) to separate, in time, the initial sound from the dense reverberation. This leaves the initial sound uncluttered and more distinct, as it stands alone for the duration of the pre delay.

DECAY

Natural reverberation results when sound reflects off the boundaries of a confined space. The character of the reverberant sound depends on the size and shape of the space, the composition of the boundaries, and the presence (or absence) of objects within the space that absorb or reflect sound energy. "Decay time" is defined as the time required for the reverberant sound to decay to one millionth (-60 dB) of its original energy.

When the green light under DECAY is on, the VALUE display indicates the decay time in seconds. As you vary it via the up/down pushbuttons you will notice the step size is tailored to provide greater resolution at shorter decay times. Decay time range is from 0.1 to 25 seconds.

H.F. DAMPING

As sound travels through air, or reflects off soft surfaces, the higher frequencies are absorbed quicker than the rest of the sound. This high frequency absorption is called "damping". The greater the amount of damping, the "softer" or less "live" the apparent room sounds.

H.F. DAMPING is variable over a relative range of 0 to 19. At 0 there is no damping and the reflective qualities of the decay are brighter than normally occur in nature. Values from 1 to 3 sound like a room with bare smooth walls. Values from 4 to 9 increase the amount to where the walls are hung with heavy curtains. Values beyond 9 are unnatural and give a very muffled decay and interesting effects, especially with long decays.

CONTROLS AND OPERATION

POSITION

The POSITION control allows you to change your apparent position in the simulated room by varying the mix of initial sound and later reverberation. When set to 0, your position is at the front of the room, near the sound source. A setting of 5 puts you in the middle of the room. A setting of 9 puts you near the back of the room. As you move away from the front of the room, you hear less of the initial sound and more reverberation.

K/I MODE

Press the pushbutton under K/I MODE twice. The red light above K/I MODE should be on and the VALUE display will show a number from 0 to 3. This mode allows you to program the function of the KILL/INF pushbutton.

MODE 0: disables the KILL/INF pushbutton and is normally not used. When changing presets, if you have one of the other K/I MODEs selected (e.g. 1,2 or 3) and KILL/INF is activated, if K/I MODE on the preset you are going to is set to 0, KILL/INF will be deactivated. This mode is useful in MIDI applications and will be covered more in the MIDI section.

MODE 1: In this mode the KILL/INF pushbutton kills the reverberant signal when activated.

MODE 2: The KILL/INF pushbutton when activated kills the decay position of the signal in this mode. Early reflections are still enabled.

MODE 3: The KILL/INF pushbutton when activated puts the unit in an infinite hold mode, sustaining the signal for a very long time. This effect is similar to the sustain pedal on a keyboard.

Remember that K/I MODE only selects what the KILL/INF pushbutton will do when activated, it does not activate the function.

CONTROLS AND OPERATION

DIFFUSION

The DIFFUSION control varies the reverb sound from rough to smooth by increasing echo density and filling in the spaces between individual echoes. A setting of 0 creates the illusion of sound bouncing off many surfaces and produces a choppy effect, especially with percussive material. As the diffusion is increased to maximum, (9), the effect is progressively smoothed to provide a more natural sounding reverberation better suited for vocals.

MIN DECAY

All normal rooms in the DR1 can be made dynamic rooms by setting the MIN DECAY value to be less than the DECAY value. Normally the MIN DECAY value equals the DECAY value. However, if you select MIN DECAY and make its value less than the DECAY value, the two function independently. By raising the MIN DECAY value, until it equals the DECAY value, you connect the two and they track again.

By setting the MIN DECAY value for a short decay time and the DECAY value for a long decay time, sound events in normal program material will quickly fade away at higher signal levels, keeping the sound clean. At the end of the material, or during quiet pauses, the decay time will revert to the maximum value originally set by the DECAY value.

This dynamic reverberation is not a naturally occurring phenomenon, however, it can be used quite effectively to provide a distinct reverberation free of the obscuring din that can accumulate with long decay times.

MIDI PGM and MIDI CHAN

Operation of the MIDI functions with MIDI will be discussed in the MIDI section. These functions are not stored in a Preset and function independently from the rest of the VALUE functions. When MIDI PGM is selected a MIDI program number appears in the VALUE display and the preset that will be selected by this MIDI program number appears in the PRESET display. Selecting any of the non-MIDI functions will return to the PRESET display the active preset.

CONTROLS AND OPERATION

OTHER CONTROLS

KILL/INF

This pushbutton when active performs the function assigned by the K/I MODE. If K/I MODE is set to 1 then the reverb signal will be killed when the switch is activated. The far right decimal point in the VALUE display is used to indicate the KILL/INF active status. KILL/INF on the REMOTE and the rear panel KILL/INF jack act the same as the front panel KILL/INF pushbutton.

INPUT LEVEL and OVF INDICATORS

The input signal level is indicated by an LED bar-graph display on the front panel. This level meter is calibrated in 3 dB steps from -21 to 0 dB. For maximum dynamic range the input level should be adjusted so that the level display reads about 0 dB on average signal peaks.

The OVF indicator (at the top of the level display) warns when numerical values in the digital signal processor exceed the processor's calculating range. This may produce audible distortion. Overflow is most likely to occur with material having an abundance of high frequencies (such as cymbals) in combination with long decay times or with high position values. Under these conditions, you may need to adjust the input level.

REMOTE CONTROL

The REMOTE, furnished with the DR1, allows access to virtually all of the parameters on the front panel. The only front panel functions that are not accessible are the LOCK pushbutton and the REVERB LEVEL controls.

Selecting a VALUE is performed differently by the REMOTE, in that pressing the FUNCTION pushbutton on the REMOTE, increments to the next VALUE parameter and holding FUNCTION down, automatically increments you through all the VALUE parameters. Once you have stopped at a parameter you wish to change, the up/down pushbuttons beside VALUE on the REMOTE allow you to increase or decrease that parameters value.

Since access to the VALUE sections pushbuttons is different you cannot enable FACTORY DEMO Mode or FACTORY SETUP from the REMOTE. These two special functions are described later in the manual and are not needed in normal use.

CONTROLS AND OPERATION

SPECIAL EFFECTS ROOMS

As mentioned earlier, rooms EF2, ERO, EGO and DDL are special effects rooms. They have unique parameters and use the VALUE section differently.

EF2

ROOM EF2 creates percussive flanging effects in one mode. In the other mode it adds a very resonant drone to the signal.

The DIFFUSION parameter selects the effects mode. Set mode to 1 for percussive flanging; mode 2 selects resonant mode.

MIN DECAY sets the time it takes for the flange to reach its climax in percussive flange mode (most noticeable in the range of 0.5 to 1.0). In resonant mode it affects the attack or build qualities of the resonance, a fairly subtle effect, most noticeable in the range of 0.5 to 1.0.

DECAY sets the time it takes for the effect to diminish in percussive flange mode and resonant mode.

H.F. DAMPING performs its normal functions and acts as a variable high frequency rolloff.

POSITION acts as a programmable level control on both effects. Level control is needed with this effect because in resonant mode the output level can vary depending on other parameters and their interaction with the signal.

PRE DELAY controls flutter frequency in percussive flange mode and drone frequency in resonant mode. Its range is from 7 Hz to 100 Hz. In percussive flange mode it varies the effect from a subtle flange to a distinct stepped flange. In resonant mode it allows you to tune the drone sound to the signal material.

ERO

ROOM ERO is used to create Reverse reverb effects, where the reverberation level increases with time until it comes to an abrupt halt at the selected decay time.

PRE DELAY performs its normal function with the range limited to 0 to 135ms.

CONTROLS AND OPERATION

DECAY sets the amount of time for the signal to increase or swell; at the end of this time the signal stops. Its range is from .1 to 1.2 seconds.

H.F. DAMPING performs its normal function.

K/I MODE 2 and 3 are not available as there is no normal reverb decay with this effect.

DIFFUSION acts as normal with a limited range of 4 to 6.

MIN DECAY and POSITION are not applicable to this effect, therefore a dash (-) will show in the VALUE display.

EGO

ROOM EGO is used for gated reverb effects, where the decay comes to an abrupt halt at the end of the selected decay time.

All of the VALUE parameters function as they do for ERO.

DDL

ROOM DDL (displayed as ddl) reconfigures the DR1 to operate as a multi-tapped programmable digital delay with some interesting features.

DECAY sets the delay time of the LEFT channel in 10ms steps from .01 to 1 second.

MIN DECAY sets the delay time of the RIGHT channel in 10ms steps from .01 to 1 second.

H.F. DAMPING sets the high frequency rolloff of the regenerated signal.

POSITION sets the amount of regeneration, with 0 being none and 15 being maximum regeneration.

PRE DELAY sets the length of the feedback path, with a range of .01 to 1 second in 10ms steps.

K/I MODES 0 thru 3 are available in DDL. Modes 0 and 1 function normally. Mode 2 kills regeneration when activated. Mode 3 acts like "Repeat Hold" or "Hold" on a digital delay.

CONTROLS AND OPERATION

If you think of the delay as one long chunk of memory, with audio feeding in one end, you can independently select where you tap off for RIGHT channel, LEFT channel, and for feedback when regenerating the signal. This flexibility permits you to create DDL effects that are not possible with a standard digital delay.

APPLICATIONS

H3 is a medium warm hall. PRESET G3 is set up for a structurally filled hall with a close image and a small amount of spread. The reflected sounds swell into a warm sounding mix during the decay. A good hall for vocals.

H4 is a large structurally filled hall, well balanced with a wide stereoscopic image that fills out with reflections during the decay. PRESET G4 was set up for a mix of program material and tends to represent an acoustically balanced hall that reflects all registers of sound and absorbs higher frequencies. The decay builds to a wide, full representation of the program material, moderately diffuse due to structure.

H5 represents a large concert or event auditorium. PRESET G5 simulates what a concert might sound like in an auditorium with you centrally located. The sound bounces, swells, merges, and then loses high end due to people and nonbaffled high ceilings. The image is wide with good separation.

EFFECTS

EF1 has a large, expansive and natural reverb related property. The effects that can be generated with this ROOM are almost larger than life, but occur every day in nature. In PRESET G6 we have simulated the characteristics of a cavern, with all of its intrinsic anomalies. The low building overtones, wavering, echoes, almost immediate reflections, and subsequent damping factors can all be heard. From the confining sound quality of this setting, let's reverse the imitation to that of an outdoor situation. PRESET G7 captures the sonic response of sound as if you were shouting into a large canyon. There is an overwhelming fullness to the sound that disappears as the decay tails out.

EF2 is unnatural and may be used to create special sounds. Both PRESET G8 and G9 create percussive flanging. G8 is more of a conventional flange, with the sound going through the top and then down. G9 produces a step flange much like the sound is arpeggiated as it ascends. The effect as heard in PRESET H0 is yet another effect EF2 is capable of producing. This sound has a tonal, metallic like drone imposed on the input material. Try this preset with vocals for an interesting alien voice sound.

APPLICATIONS

ERO is the REVERSE Reverb setting. A distinctly unnatural effect that can be best described as backwards reverb. With this setting the reverberation level increases with time, then comes to an abrupt halt. PRESET H1 gives you a quick decay that sounds mostly like a reverse slap. When used with percussion devices like tuned toms played in triplets, the consequent sound is particularly interesting. PRESET H2 allows the input material to swell into a reverse decay. Vocals, or one-shot percussive material turns into a surrealistic sound while maintaining clarity.

EGO has a natural decay, but instead of continuing gradually to silence, the reverberation comes to an abrupt halt at the end of the selected decay time. This GATED Reverb provides the illusion of space without the clutter of a long decay. In PRESET H3, the input signal will sound like it is being processed by a multi-tap delay, only the resulting output is spacious, with no regenerative overtones. This preset is best represented when drums are used for the input source.

DDL is a true multi-tapped digital delay that can give some stereo effects not normally available with most DDLs. PRESET H4 is configured to provide a ping-pong effect between the left and right channels. By using the infinite setting in the K/I MODE, you can capture a sound and have it bounce back and forth between the two outputs. PRESET H5 best represents the digital delay as a reverberation device. Back in the 1960's, there was a device called the Echorec. The values used in this preset simulate the sound produced by the Echorec, only with much better bandwidth and signal quality.

The next four PRESETS help to show some of the capabilities of the DR1. PRESET H6 is an arbitrary room. The room characteristics are those of another popular digital reverb. This setting demonstrates the vast flexibility the DR1 is capable of producing. PRESET H7 represents a tunnel, with you near one end and the signal source at the other. For an interesting effect, move the position to a lower number while listening to the program material. As the POSITION VALUE is changed, you can readily notice how your perspective changes from close to far. PRESETS H8 and H9 demonstrate the use of the dynamic decay properties of the DR1. With any program source, you will be able to realize the convenience of full clear sound with decay times in excess of ten seconds.

These PRESETS are primarily a starting point and reference to help you better understand the potential that lies at your fingertips. With your talent and ART technology, the possibilities are almost endless! Go ahead, experiment.

MIDI

MIDI PGM allows any of the 128 MIDI programs to be assigned to any of the DR1 presets. When MIDI PGM is selected, a MIDI program number appears in the VALUE display, and, the preset that would be recalled if a MIDI program change message were received, appears in the PRESET display. As always, the LOCK and CURRENT indicators show the status of the PRESET which appears in the display.

For each of the 128 MIDI programs (numbered 0 to 127) there is a corresponding PRESET. Any of the 30 factory presets, 100 user presets or a special "kill" preset may be assigned to any of the MIDI programs.

The "kill" preset (displayed as --) is different from the others. It is not really a preset. When recalled, it has the effect of setting K/I MODE to 1, and activating that mode. The result is that recalling this preset allows, via MIDI, to turn off the reverb output. That is, it performs a KILL REVERB. This allows a MIDI program change message to deactivate the DR1. The inverse of this may also be achieved. By setting the K/I MODE of a preset to 0, when that preset is activated (either by pressing the RECALL button or a MIDI program change message) the DR1 will be activated with the preset chosen.

While the VALUE section has MIDI PGM selected, you may set up which DR1 preset will be recalled when a MIDI program change message is received. Adjust the VALUE display to show the desired MIDI PGM, and set the PRESET display to show the desired PRESET. That is all there is to it, you do not need to press any other buttons. There are some other things that may be done while MIDI PGM is selected. You can step through the MIDI PGM numbers and see which DR1 preset would be recalled. If you want to hear the preset that would be recalled, press the RECALL button. You may also press the STORE button to save the current front panel settings at the PRESET displayed. The LOCK button also works while MIDI PGM is selected, it locks the preset displayed, but does not lock the association between the MIDI PGM and PRESET. This association is not lockable.

In order to use the MIDI features, you must have another MIDI equipped device, such as a synthesizer, which sends MIDI program change messages. Using a standard MIDI cable, connect the MIDI OUT from the sending device to the MIDI IN on the DR1. Set the transmit channel of the sending device to match the MIDI CHAN on the DR1, or set the DR1 to OMNI on.

MIDI

Select the MIDI PGM parameter in the DR1. When the DR1 receives messages to change programs, the program number will appear in the VALUE display on the DR1, the preset associated with this program will appear in the PRESET display, and, the preset will be recalled, so the CURRENT indicator will be on. You can watch presets being recalled as program change messages are received. If you want to change the preset that was recalled, simply adjust the PRESET to the one desired, and press RECALL to hear it.

MIDI TECHNICAL SUMMARY

The DR1 provides MIDI IN and MIDI THRU jacks. Hardware has been provided such that the MIDI THRU jack may be used as a MIDI OUT jack in the future, under user control.

The initial release of the DR1 provides the following function:

1. The DR1 recognizes MIDI program change messages to recall any of the DR1's presets including the 30 factory presets and 100 user presets. In addition to these presets, a special preset is provided to allow the DR1's reverb output to be "killed". Each of the 128 MIDI programs may be independently assigned to any of the above presets. These assignments are held in battery backed up RAM and may be changed at any time by the user.

2. The DR1 will receive messages on any of the 16 MIDI channels. The user can easily set which MIDI channel to receive on, as well as whether or not the DR1 is in OMNI mode. The DR1 channel may also be set to OFF in which case all MIDI messages of any type will be completely ignored. The DR1 recognizes channel mode messages to set OMNI on and OMNI off.

3. The DR1 will set OMNI on when a system reset message is received.

On power up, if the MIDI channel was previously OFF, it will remain OFF. If the MIDI channel was not OFF, OMNI mode will be set on and the channel will remain the same as it was when the DR1 was last powered off.

RECOGNIZED RECEIVE DATA

Channel Voice Messages:

Status	Second	Third	Description
1100nnnn	0ppppppp		Program change ppppppp = 0 -127

Channel Mode Messages:

Status	Second	Third	Description
1011nnnn	01111100	00000000	OMNI mode OFF
1011nnnn	01111101	00000000	OMNI mode ON

The 3rd byte is ignored and may be omitted.

MIDI TECHNICAL SUMMARY

System Realtime Messages:

<u>Status</u>	<u>Description</u>
11111111	System reset, simply forces OMNI on in the DR1.

FUTURE PLANS

The initial release of the DR1 contains a conservative MIDI implementation. As we obtain feedback from our users, we plan to implement more features to the DR1 MIDI interface.

Some of the functions we have in mind are:

- Allow the DR1 to be fully controlled by MIDI (i.e. have some other device be able to change a parameter such as DECAY TIME).
- Allow one DR1 to slave from another.
- Allow the DR1 to send all the parameters that define a preset.

As these features are added, anyone who owns a DR1 will be able to upgrade their DR1 with a software update for a small cost. This follows with ART's tradition of software updates for its previous software based products, the 01a and DR2a reverbs.

REVERBERATION PRINCIPLES

The spring reverb is one of the oldest types of reverb simulators. It consists of a long, small diameter spring stretched between two transducers or pickups. One converts the audio signal into a wave which propagates through the spring. The other senses the spring's mechanical energy and translates it back into an electrical signal. In the process of traveling through the spring, sound picks up characteristics a little like natural reverberation. The simplest spring reverbs have only two boundaries for waves to reflect off of at either end of the spring. The resulting reverb effect may have pronounced resonances and sound "boingy". Audio delay lines with simple regeneration suffer from similar shortcomings:

The plate reverb substitutes a rectangular metal plate for the spring and has pickups at various points around the periphery. Now there are two dimensions and four boundaries. The reverb effects are fuller and more complex. The response is more balanced. The range of effects is limited, but the sound is more pleasing than that of a spring reverb.

Digital reverbs forsake mechanical contrivances in favor of digital processing of audio signals. A digital reverb can simulate the sound of spring and plate reverbs as well as the reverberation of real structures. With digital techniques, the state of electronics technology, not the underlying approach, is what limits the degree of realism possible.

We still have a long way to go, however. No current digital reverb (including the DR1) can exactly model the actual mechanisms of natural reverb (or the actual mechanisms of a plate reverb, for that matter). The considerable processing power and speed required is not likely to be economically available in the near future. Instead, the approach taken is to develop a reverb of sufficient complexity so that by carefully adjusting various parameters we can produce a sound similar to that of a real structure. In other words, the "sound" of a structure is simulated, not the conditions that produce that sound.

Lest we leave you with a negative impression, we must point out that digital techniques can produce quite realistic reverberation, with a degree of control over reverb parameters that's not possible with real structures. And the special effects attainable are totally unique.

TECHNICAL OVERVIEW

This section presents a brief overview of the technology underlying the design of the DR1. First we'll describe the major functional blocks of the DR1's circuitry and then we'll examine some basic elements of digital signal processing (DSP) used in creating reverb effects.

Although the DR1 is predominantly digital, it must interface with analog audio signals. The input amplifiers bridge a balanced line and provide buffering between the audio source and the DR1's internal circuitry. Next, input filtering removes unwanted very high frequency material. The signal is sampled at discrete instants of time and converted into a continuous stream of digital numbers by the analog-to-digital (A/D) converter. It is necessary to filter the signal before it is sampled to prevent "aliasing". This is a type of distortion which occurs when the incoming signal has frequency components greater than half of the sample rate. After conversion, the numbers are stored in memory.

At the heart of the DR1 is the high-speed digital signal processor, capable of performing millions of arithmetic calculations per second. The digital signal processor retrieves the encoded numbers representing the input signal from memory and processes them according to the currently selected parameters. It then stores the calculated results back into memory. These results represent the original signal with reverberation added.

At regular intervals, the processed data is recalled from memory and converted back into an audio signal by the digital-to-analog (D/A) converter. Alternate samples go to each of the two output sections and produce the left and right parts of a stereo image. The output filters remove very high frequency noise introduced by the sampling process. Finally, the output amplifiers buffer the signals and provide line driving capability.

TECHNICAL OVERVIEW

The microprocessor, along with its operating software (in EPROM), determines the "personality" of the DR1. It monitors the front panel controls, MIDI interface, REMOTE control, and the rear panel external control jack for user input and outputs setting information to the user via the front panel displays. Button depressions are translated into commands understood by the digital signal processor. Thus the user can make quick changes to the reverberant sound using intuitive concepts like "room types" without being concerned about the details of digital signal processing. If you would still like to know more about the "details" anyway, see "DSP and Reverberation" below.

The microprocessor also controls the storage of front panel settings in the preset memory and their retrieval for later use or immediate comparison. A lithium battery preserves the presets (and the current front panel settings) when AC power is removed. This battery has an extremely long life and should last for at least ten years. Contact the factory if replacement ever becomes necessary (indicated by lost presets).

DSP AND REVERBERATION

The following presents a simplified description of how reverb is created using digital signal processing. The two basic elements employed are the FIR and IIR filters.

FIR stands for "FINITE IMPULSE RESPONSE". When driven by an impulse (a "click"), the output of this filter will settle in a finite amount of time. The FIR filter may be represented as a tapped delay line, or a series of delays, whose outputs are summed together.

Each tap may have its own coefficient or "level control". No feedback is applied.

IIR stands for "INFINITE IMPULSE RESPONSE". If the arithmetic precision were unlimited, the output of this filter would never settle completely when driven by an impulse. Hence, its impulse response would be infinite. There are many possible IIR filter configurations. The main distinguishing characteristic, as opposed to FIR filters, is the presence of feedback wrapped around them. In other words, some of the output signal is fed back to the input or regenerated. This configuration is like that of many digital delays.

TECHNICAL OVERVIEW

Reverb is created by combining many of these FIR and IIR filter elements in various ways, with varying time delays and coefficients. The relationship of each of these variables to the resultant sound of the reverberation is very complex. Often, changing only a single user parameter, such as decay time, requires many changes to the digital signal processing variables. As mentioned before, the DR1s microprocessor takes care of these details, freeing the user to concentrate on the sound.

MISCELLANEOUS

REVISION LEVEL

On power up, the DR1 indicates its software revision level in the preset display window (eg. 1.0).

FACTORY DEMO MODE

By pressing the ROOM, DECAY and POSITION pushbuttons simultaneously, you put the DR1 into FACTORY DEMO MODE. In this mode the unit sequences thru its factory presets, displaying all of the VALUE parameters of each PRESET and processing audio with the indicated PRESET. Pressing any pushbutton on the front panel or REMOTE, takes it out of this mode and returns you to normal operation. This mode has no effect on your user presets and is primarily intended for demonstration purposes. If power is removed while the DR1 is in FACTORY DEMO MODE; on power up it will still be in FACTORY DEMO MODE until you press any pushbutton. If you stop the demo and then restart it, the demo will continue from where you left off. In this mode the DR1 sequences thru all of its factory presets in approximately 3 minutes.

FACTORY SETUP

WARNING: this mode is primarily intended for initializing the DR1 at the factory. It initializes all of the DR1's parameters, erases all user preset memory, and loads factory presets into the user preset memory area. You should never have to use this mode and will not want to if you have painstakingly stored in many user presets of your own. Therefore we make it pretty hard for someone to inadvertently perform a FACTORY SETUP. However if you want to return all user presets in the unit to a known condition, the factory setup is performed by simultaneously pressing the LOCK, PRE DELAY, and KILL/INF pushbuttons.

SPECIFICATIONS

HARDWARE DEPENDENT

Maximum Input Level	+12 dBV
Maximum Output Level	+12 dBV
Operating Level	0 dBV HIGH setting -12 dBV LOW setting
Input Impedance	47K ohms balanced
Output Impedance	1K ohms
Bandwidth	35kHz Dry (unprocessed) 14kHz Reverb (processed)
Dynamic Range	greater than 90 dB in all modes
D-A Converter	16 bits linear
Power Requirements	105 - 125 volts AC, 50 - 60 Hz 25 watts, fused, (export units configured for destination country)
Dimensions	1.75" high, EIA rack width, 9" deep

SOFTWARE DEPENDENT

(Revision level 1.0)

Decay Time	0.1 - 25.0 seconds, all normal rooms different in some effects programs
Pre Delay	0 - 200 ms, in 1 ms increments different in some effects programs
Factory Presets	30, F0 - H9
User Presets	100, 00 - 99, all user programmable internal battery back-up
Room Types	20
MIDI Receive Channel	1 - 16, OMNI: ON/OFF
MIDI Program	0 - 127, assignable to any preset

NOTE: All software specifications subject to improvement and expansion, as they are defined by the Revision level PROM furnished with the unit.